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III. **Solution by G. W. GREENWOOD, M. A. (Oxon), Lebanon, Ill.**

$\Pi(\alpha\beta-\gamma\delta)=\alpha\beta\gamma\delta(\Sigma\alpha)^2-(\Sigma\alpha\beta\gamma)^2=m^2(-a)^2-(-am)^2=0.$

Hence the product of any one pair of the roots equals that of the remaining pair.

Solved by A. H. Holmes by actual computation of the roots.
Also solved by the Proposer.

207. **Proposed by A. J. PAULSEN, San Francisco, Cal.**

Solve $x^4+y^4=2x^2y^2$; $x+y=a$.

Solution by EDWIN L. RICH. Lehigh University, and A. H. HOLMES, Brunswick, Maine.

Writing the first of these equations in the form $(x+y)^2(x-y)^2=0$, it is easily seen, since $x+y=a$, that the four values of x are ∞, $-\infty$, $\frac{1}{2}a$, $\frac{1}{2}a$; and those of y are $-\infty$, ∞, $\frac{1}{2}a$, $\frac{1}{2}a$.

Also solved by G. B. M. Zerr, G. W. Greenwood, M. E. Graber, and J. Scheffer.

GEOMETRY.

233. **Proposed by S. F. NORRIS, Professor of Mathematics, Baltimore City College, Baltimore, Md.**

If from any point on a circle circumscribed about a triangle perpendiculars are dropped to the sides of the triangle, the feet of these perpendiculars lie on a line. [Ashton's *Plane and Solid Analytic Geometry*, page 87, 11th example].

Remark by G. W. GREENWOOD, M. A. (Oxon), Lebanon. Ill.

See solution of Geometry Problem number 184, August-September, 1902.

234. **Proposed by M. E. GRABER, A. B., Instructor in Mathematics and Physics in Heidelberg University, Tiffin, Ohio.**

Find the curve which is reciprocal to a circle and define it as a locus.

I. **Solution by the PROPOSER.**

If A be the center of the given circle, P any doint on it; x and a lines corresponding to P and A; and X the point ax, $AP=\dfrac{OA.OX}{Ox}\sin ax$. Denoting OX by z the ratio $\sin ax:\sin zx$ is constant. The reciprocal to a circle is then the envelope of a line x which divides the angle between a fixed line a and a variable line z passing through a fixed point O, into parts whose sines are in a constant ratio. Defined as a locus, the reciprocal curve to a circle is the path of a point which moves so that its distance from a fixed point varies as its distance from a fixed straight line. [Lachlan's *Modern Pure Geometry.*]

II. **Solution by G. W. GREENWOOD, M. A. (Oxon), Professor of Mathematics and Astronomy in McKendree College, Lebanon, Ill.**

See Russell's *Pure Geometry*, Chapter VIII, §11, or Salmon's *Conic Sections*, §308. The following is an analytic solution. Call the center of the given circle C and its radius a. Call the center of the circle of reciprocation O. Denote CO by d; at any point P of the given circle draw a tangent to it, and through O draw a perpendicular to this circle, meeting it at N. Denote PCO by θ. The locus of N is therefore $r=a-d\cos\theta$, and the inverse of N with respect to the circle whose center is O, that is, the reciprocal of the given circle has for its equation

$$\frac{k^2}{r}=a-d\cos\theta.$$

Hence the required locus is a conic, whose focus is O, and eccentricity d/a. It is therefore an ellipse, an hyperbola, or a parabola, according as $d<$, $=$, or $>a$.

Also solved by G. B. M. Zerr.

235. Proposed by **W. J. GREENSTREET, A. M.**, Editor of The Mathematical Gazette, Stroud, England.

Any point on an ellipse is joined to the corners of an inscribed square. Find the anharmonic ratios of the pencil so formed.

I. Solution by **G. W. GREENWOOD, M. A.** (Oxon), Lebanon, Ill.

We can show that the center of the square is the center of the ellipse and that the sides are parallel to its axes. Now anharmonic ratios are unaltered by projection. Hence project the ellipse into a circle whose diameter is $2b$, where a, b are the semi-major axis and semi-minor axis, respectively. We have a circle with an inscribed rectangle $ABCD$ where $\frac{AB}{AD}=\frac{a}{b}$. Consider the pencil $P(ABCD)$ where P is any point on the circle. The anharmonic ratio is

$$\frac{\sin APB.\sin CPD}{\sin CPB.\sin APD}.$$

Calling $\angle APB$, θ, we have

$$\frac{\sin\theta.\sin\theta}{\cos\theta.\cos\theta}=\tan^2\theta.$$

Now $\tan\theta=\frac{AB}{AD}=\frac{a}{b}$. Hence the anharmonic ratio is $\frac{a^2}{b^2}$.

II. Solution by **J. SCHEFFER, A. M.**, Hagerstown, Md.

Let $ABCD$ represent the inscribed square, P any point. Let PD and PC intersect AB at M and N. Let $2c$=length of square, and $a^2y^2+b^2x^2=a^2b^2$ the equation of the ellipse; and x_1, y_1 coördinates of point P. The coördinates of A, B, C, D are respectively (c, c), $(c, -c)$, $(-c, -c)$, $(-c, c)$. Hence the equation of PD is $y-c=\frac{y_1-c}{x_1+c}(x+c)$; of PC, $y+c=\frac{y_1+c}{x_1+c}(x+c)$; of AB, $x=c$.

$\therefore$ The coördinates of point $M=\left(c,\ c+\frac{(y_1+c)2c}{x_1+c}\right)$; of N, $\left(c,\ -c+\frac{(y_1+c)2c}{x_1+c}\right)$;

$$\therefore AM=\frac{2c(c-y_1)}{c+x_1},\ BN=\frac{2c(c+y_1)}{c+x_1},\ AB=2c,\ MN=\frac{2c(x_1-c)}{x_1+c}.$$